

Preface

Many real life problems suffer from uncertainty, imprecision, vagueness to name a few. Conventional computing paradigms often fall short of offering comprehensive solutions to them. Even latest soft computing paradigms appear not too robust to handle the situations. This is primarily because each individual constituent of Soft Computing suffers from shortcomings, somehow or other. In this backdrop, limitations of one such Soft Computing constituent may often be found to be supplemented by another constituent giving rise to hybridization. Hybrid computing is a paradigm which addresses fused impact of a member of Soft Computing constituents these issues to a considerable extent. This book is intended to encompass such hybrid computing techniques reported in the literature.

Soft Computing, as the name suggests, deals with the soft meaning of concepts. This is a relatively new computing paradigm which entails a synergistic integration of essentially four other computing paradigms, viz., neural networks, fuzzy logic, rough sets and evolutionary computation, incorporating probabilistic reasoning (belief networks, genetic algorithms and chaotic systems). These computing paradigms are conjoined to provide a framework for flexible information processing applications designed to operate in the real-world. Bezdek referred to this synergism as computational intelligence. According to Prof. Zadeh, soft computing is “an emerging approach to computing, which parallels the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision.” Soft computing technologies are robust by design, and operate by trading off precision for tractability. Since they can handle uncertainty with ease, they conform better to real-world situations and provide lower cost solutions. The four components of soft computing differ from one another in more than one way. They operate either independently or in unison depending on the domain of applications. Hybrid computing stems from the synergistic integration of the different soft computing tools and techniques as has already been indicated. The fusion of these techniques towards achieving enhanced performance and more robust solutions can be achieved through appropriate hybridization.

An intelligent machine inherits the boon of intelligence by virtue of the various methodologies offered by Soft Computing paradigm encompassing fuzzy and rough set theory, artificial neurocomputing, evolutionary computing, as well as approximate reasoning. At times, situation demands in reality, where any of the techniques listed above does not provide any comprehensible solution but an effective symbiosis of more than one of the above techniques offers a formidable solution. This gives rise to the advent to several hybrid methodologies. Of late, there is enormous growth of research exploration of injecting elements of intelligence using efficient hybrid techniques. All these initiatives indicate that the individual soft computing techniques do not behave in conflicting manner rather behave complimentary to one another. In fact, recent reports reveal the inherent strength of such hybridization of computation methods.

The objective of the present endeavor is to bring a broad spectrum of application domains under the purview of hybrid intelligence so that it is able to trigger further inspiration among various research communities to contribute in their respective fields of applications, thereby orienting these application fields towards intelligence.

Once the purpose, as stated above, is achieved a larger number of research communities may be brought under one canopy to ventilate their views and ideas in a more structured manner. In that case, the present endeavor may be seen as the beginning of such an effort in bringing various research applications close to one another.

The target audience of the intended book is the relevant research community. To be precise, the book is aimed to establish the missing link between the research standing in the relevant field and that is upcoming. Hybridization would surely and certainly help the readers grasp the essence and utility of the different soft computing techniques in vogue.

The proposed book would come to the benefits of several categories of students and researchers. At the students' level, this book can serve as a treatise/reference book for the special papers at the masters level aimed at inspiring possibly future researchers. Newly inducted PhD aspirants would also find the contents of this book useful as far as their compulsory coursework is concerned.

At the researchers' level, those interested in interdisciplinary research would also benefit from the book. After all, the enriched interdisciplinary contents of the book would always be a subject of interest to the faculties, existing research communities and new research aspirants from diverse disciplines of the concerned departments of premier institutes across the globe. This is expected to bring different research backgrounds (due to its cross platform characteristics) close to one another to form effective research groups all over the world. Above all, availability of the book should be ensured to as much universities and research institutes as possible to promote effective research of interdisciplinary nature.

The book is organized into two broader sections depending on the type of contributions. These are 1) Hybrid Intelligent Techniques: Concepts and Fundamentals and 2) Hybrid Intelligent Techniques: Applications. Section 1 comprises first ten chapters while Section 2 comprises rest eight following.

Chapter 1 illustrates a study of different cash crop bunch segmentation techniques that play very vital role in the process of harvesting. The cash crop under consideration happens to be the arecanut crop available in India. Different color segmentation techniques such as thresholding, K-means clustering, Fuzzy C Means (FCM), Fast Fuzzy C Means clustering (FFCM), Watershed and Maximum Similarity based Region Merging (MSRM) techniques are discussed in this chapter.

The inclusivity of discrete latent variables leading to mixture of Gaussians capturing multimodal distributions from segmented regions is initiated in Chapter 2. Further, these mixtures are analyzed in maximum likelihood framework to extract discriminatory features in compact and de-correlated feature space. In addition, this chapter demonstrates the idea of subspace mixture models in image retrieval systems.

In Chapter 3 bio-inspired techniques based on the cellular automata (CAs) and programmable cellular automata (PCAs) theory are used to develop information security systems composed of a combination of a CA as a pseudorandom number generator (PRNG) and a PCA that construct the ciphering functions of the designed enciphering scheme. The experimental results prove that the cryptographic techniques based on bio-inspired algorithms provide a formidable alternative to the conventional techniques.

Chapter 4 presents the design and comparative analysis between the most well-known column compression multipliers by WALLACE and DADDA in sub-threshold regime. The proposed multipliers outperform their counterparts exhibiting low power consumption and lesser propagation delay as compared to conventional multipliers.

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Chapter 5 adopts Support Vector Machine (SVM), Relevance Vector Machine (RVM) and Least Square Support Vector Machine (LSSVM) for determination of liquefaction susceptibility based on Cone Penetration Test (CPT) from Chi-Chi earthquake. The results show that SVM, RVM and LSSVM are the robust models for determination of liquefaction susceptibility of soil.

An overview and the use of various spectral and temporal features and the soft computing techniques that have been used for the telephonic speech recognition are elucidated in Chapter 6.

In Chapter 7, evolutionary algorithms are reviewed and discussed from concepts and designs to applications in bioinformatics. In addition, it also focuses on real world evolutionary algorithm applications in bioinformatics.

Chapter 8 presents discovering behavioral patterns within non-temporal and temporal data subsets related to customer churn. Traditional approach, based on using conventional data mining techniques, is not a guarantee for discovering valuable patterns, which could be useful for decision support. Chosen data set with temporal characteristics is the key factor after applying REFII model on it, for finding behavioral customer patterns and for understanding causes of the increasing churn trends within observed portfolio. It concludes that revealed knowledge is a base for better understanding of customer needs and expectations.

In Chapter 9, the authors discuss and evaluate the hybridization of monolithic intelligence techniques in order to achieve smarter and enhanced networking operations. Additionally, the authors provide systematic application-agnostic semantics management methodology with efficient processes for extracting and classifying high-level features and reasoning about rich semantics.

Infectious diseases, such as the recent Ebola outbreak, can be especially dangerous for large communities on today's highly connected world. Sensors on personal devices that gather information from people, and social networks analysis, allow the integration of community data, while data analysis and modeling may potentially indicate community-level susceptibility to an epidemic. In this context, an opportunistic system is proposed in Chapter 10 and evaluated for predicting an epidemic outbreak in a community, while guaranteeing user privacy.

A self supervised image segmentation method by a non-dominated sorting genetic algorithm-II (NSGA-II) based optimized MUSIG (OptiMUSIG) activation function with a multilayer self organizing neural network (MLSONN) architecture is proposed in Chapter 11 to segment multilevel gray scale images. In the same way, another NSGA-II based parallel version of the OptiMUSIG (ParaOptiMUSIG) activation function with a parallel self organizing neural network (PSONN) architecture is purported to segment the color images in this article. These methods are intended to overcome the drawback of their single objective based counterparts.

In Chapter 12, a genetic algorithm inspired by quantum computing (QIGA) is presented which is applied to determine optimal threshold of two gray level images. Different random chaotic map models exhibit the inherent interference operation in collaboration with qubit and superposition of states.

Chapter 13 bears two parts. One part of chapter introduces the adaptive illumination normalization technique using RST that classifies the image illumination into three classes based on which illumination normalization is performed using an appropriate filter. Later part of this chapter introduces use of near set theory for FRT on facial images that have previously undergone some feature modifications through plastic surgery.

Chapter 14 describes an automatic intelligent diagnostic system for Tuberculosis in the form of Sputum microscopy. In Sputum microscopy, Sputum are examined using a microscope for Mycobacterium tuberculosis. This manual process is being automated by image processing, where classification is performed by using a hybrid approach (color based and shape based).

Chapter 15 examines the capability of Minimax Probability Regression Machine (MPMR) and Extreme Learning Machine (ELM) for prediction of Optimum Moisture Content (OMC), Maximum Dry Density (MDD) and Soaked California Bearing Ratio (CBR) of soil. These algorithms can analyze data and recognize patterns and are proved to be very useful for problems pertaining to classification and regression analysis.

A hybrid approach (amalgamation of concepts of machine learning technique with soft computing paradigm) to develop an intelligent virtual chemistry laboratory (IVCL) tool for simulating chemical experiments online is presented in Chapter 16. The developed tool presents an easy to use web based interface, which takes as input the reactants and presents results in the form of type of reaction occurred and the list of possible products.

Chapter 17 presents a novel fuzzy anomaly detection method that works in two phases. In the first phase, authors propose a hybridization of Particle Swarm Optimization (PSO) and K-means algorithm with two simultaneous cost functions as well-separated clusters and local optimization to determine the optimal number of clusters. When the optimal placement of clusters centroids and objects are defined, it starts the second phase. In this phase, the authors employ a fuzzy approach by the combination of two distance-based methods as classification and outlier to detect anomalies in new monitoring data.

Registration of medical images like CT-MR, MR-MR etc. are challenging area for researchers. Chapter 18 introduces a new cluster based registration technique with help of the supervised optimized neural network. Features are extracted from different cluster of an image obtained from clustering algorithms. To overcome the drawback regarding convergence rate of neural network, an optimized neural network is proposed in this chapter.

It may be noted that there are good amount of contributions of the applications of hybrid intelligent techniques in various fields. However, any such previous effort has remained application specific i. e. aimed at identifying a specific application domain where the ingredients of hybrid intelligent techniques have been applied quite effectively. But, to the best of our knowledge, efforts to bring in multiple domains engineering and science within one framework as is evident from the diversified nature of the chapters in this book are not very frequent. In that sense, this appears to be the first such effort to accommodate cross platform applications of hybrid intelligent techniques. Speaking from the scholastic point of view, this is a noteworthy achievement in which the present endeavor may be thought of as the maiden facilitator.

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